

ERGIS

Technical Review Committee



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Disclaimer

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Goals

- **Determine the operational impact of 30% wind and solar penetration on the Eastern Interconnection at a sub-hourly resolution.**
- **Evaluate the efficacy of mitigation options in managing variability and uncertainty in the electric power system.**

The Scenarios

- **Three scenarios with different wind and solar resources**
 - State RPS Scenario: ~15% wind
 - Regional Scenario: 20% wind, 10% solar
 - National Scenario: 25% wind, 5% solar
- **New addition**
 - Existing Renewables Scenario: no new renewables
 - Findings from WWSIS-2 indicate incremental impact of renewables is higher at low penetrations than high penetrations

Operational Areas of Interest

- **Reserves**
 - Types
 - Quantities
 - Sharing
- **Commitment and Dispatch**
 - Day-ahead
 - 4-hour-ahead
 - Real-time
- **Interchange Efficiency**
 - 1-hour
 - 15-minute
 - 5-minute

Study Limitations

- **We lack:**

- Bilateral power purchase and other contractual agreement data
- Detailed operational constraints and/or complete unit-specific data in the generation models
- Capability to simultaneously model different dispatch intervals in different balancing authority areas

- **Uncertainties:**

- Future cooperation and/or sub-hourly dispatch across the interconnection
- The amount and location of variable generation
- Transmission system additions
- Generation additions and retirements
- Gas and coal prices

Agenda

Morning

- Working Group Recap
 - Generation
 - Thermal Generation Properties
 - 2020 Thermal Fleet
 - Canada
 - Ontario
 - Manitoba
 - HQ/Maritimes
- Model Update
 - 2010 Runs

Afternoon

- Transmission Working Group
 - Transmission Expansion
 - Zones
 - Transmission Monitoring
- Mitigation Working Group
 - Reserves Regions
 - Interchange Scheduling
 - Flex Reserve
 - Other Options
 - Prioritizing
- 3-Month Plan



DON'T PANIC

We'll have breaks and lunch

Working Groups Recap

- **Generation**
 - Thermal fleet properties
 - 2020 thermal fleet
 - Expansion
 - Retirements
- **Canada**
 - Ontario
 - Manitoba
 - HQ-Maritimes



Generation Working Group: April 8

- **Thermal generation properties**
 - EIPC assumptions
 - Part-load heat rate shapes
 - Min up/down times
 - Ramp rates
 - Forced and planned outage characteristics
 - Non-EIPC assumptions:
 - Unit-specific FLHR from EPA CEMS data
 - Startup and VO&M costs from Intertek APTECH

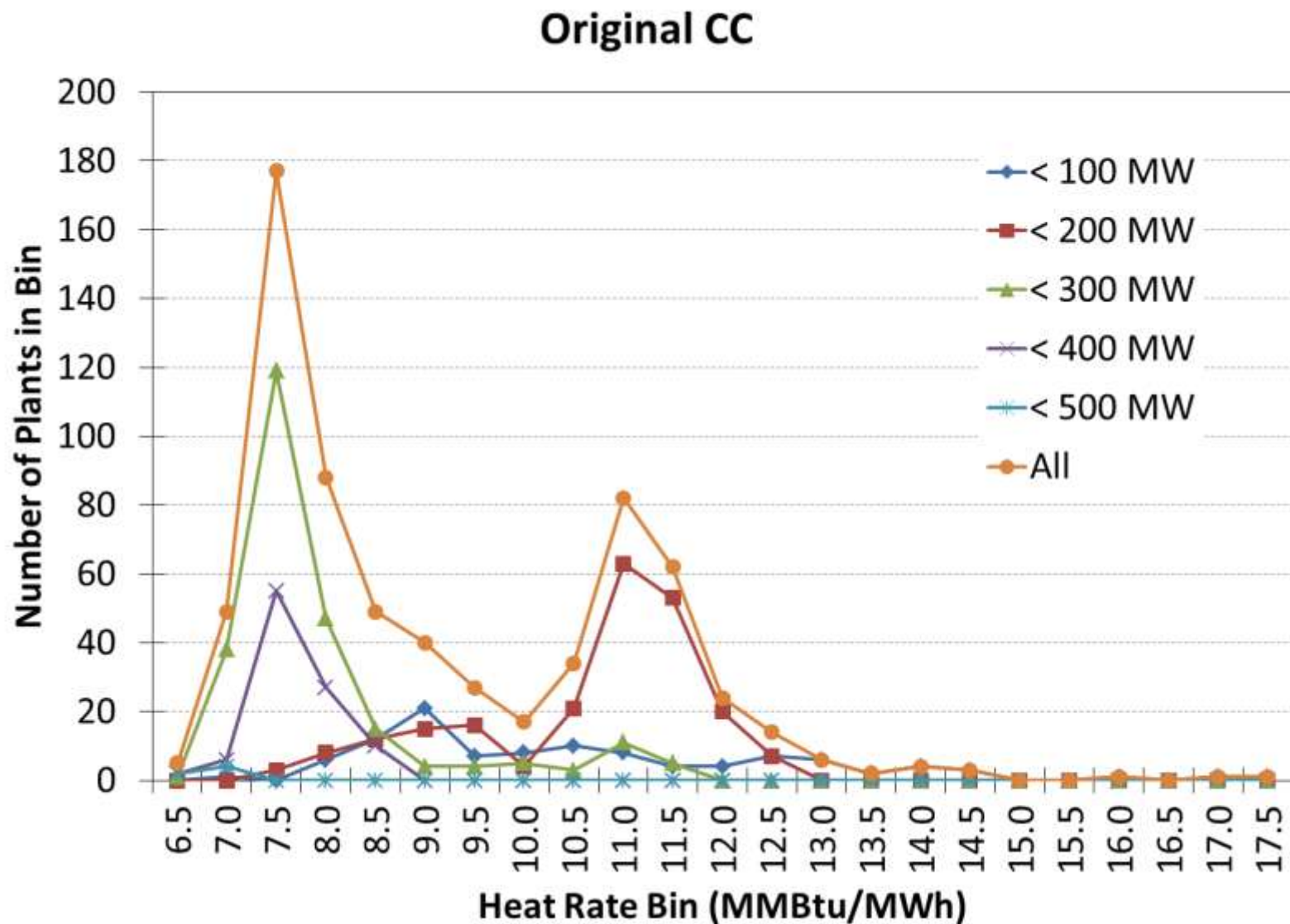
EIPC Thermal Assumptions

Category	Marginal Heat Rate (% of Max Capacity / % of FLHR)				Minimum Up Time (Hours)	Minimum Down Time (Hours)
	Step 1	Step 2	Step 3	Step 4		
CT	100% / 100%				1	1
CC	50% / 113%	67%/ 75%	83% / 86%	100% / 100%	6	8
Coal_ST < 600MW	50% / 106%	75%/ 90%	100% / 100%		24	12
Coal_ST > 600MW	30% / 110%	50% / 93%	75% / 95%	100% / 100%	24	12
Oil/Gas_ST < 600MW	30% / 110%	50% / 90%	75% / 96%	100% / 100%	10	8
Oil/Gas_ST > 600MW	20% / 110%	50% / 95%	75% / 98%	100% / 100%	10	8
Nuclear					168	168

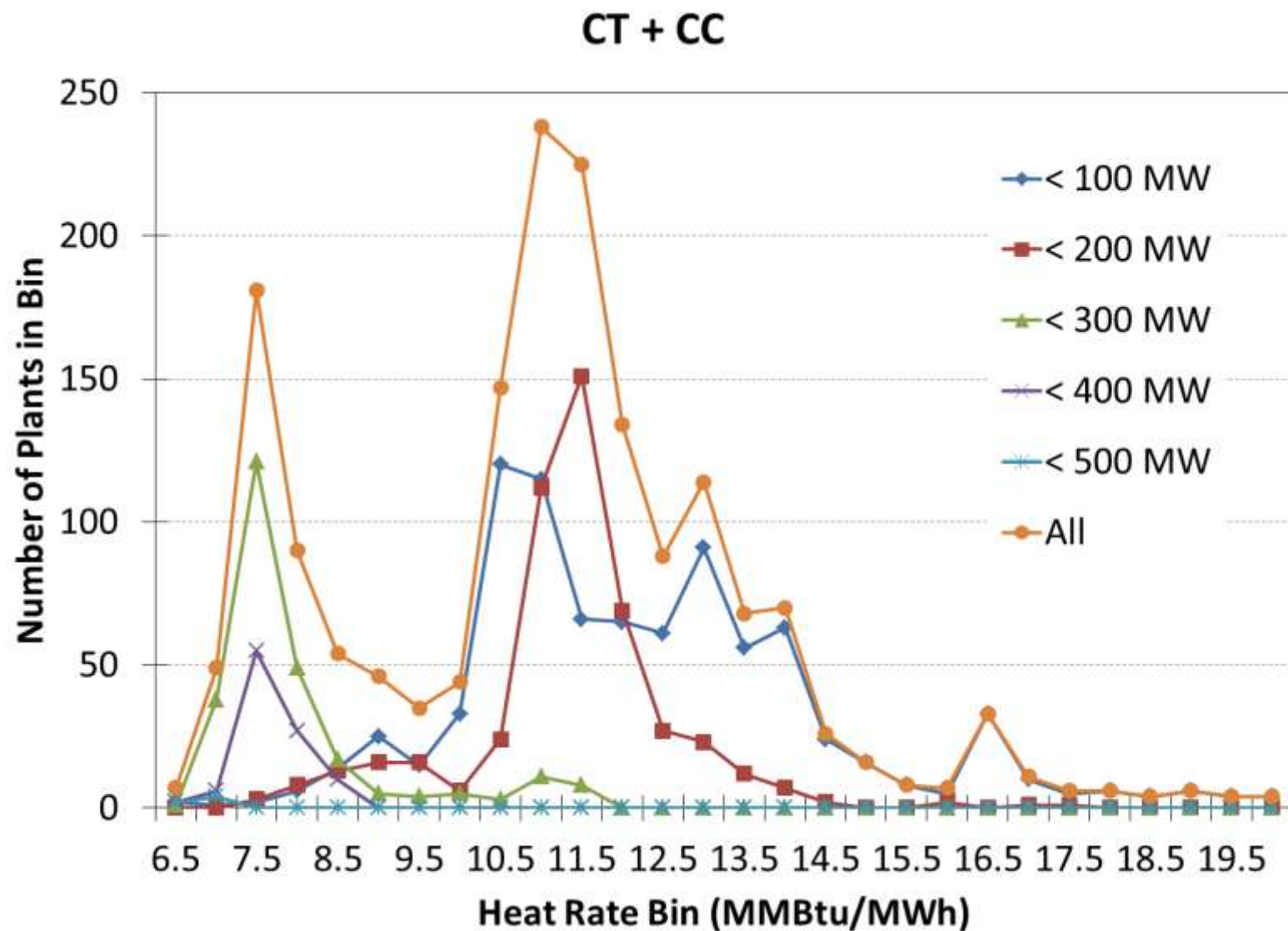
Heat Rate Distributions

- **NREL analyzed EPA CEMS fuel consumption and generation data all major combustion generators**
 - Calculated heat rates at several load fractions
- **An anomaly was identified with combined cycle and combustion turbine units**
 - Differences in reporting output from different cycles leads to bimodal distribution for CCs and CTs

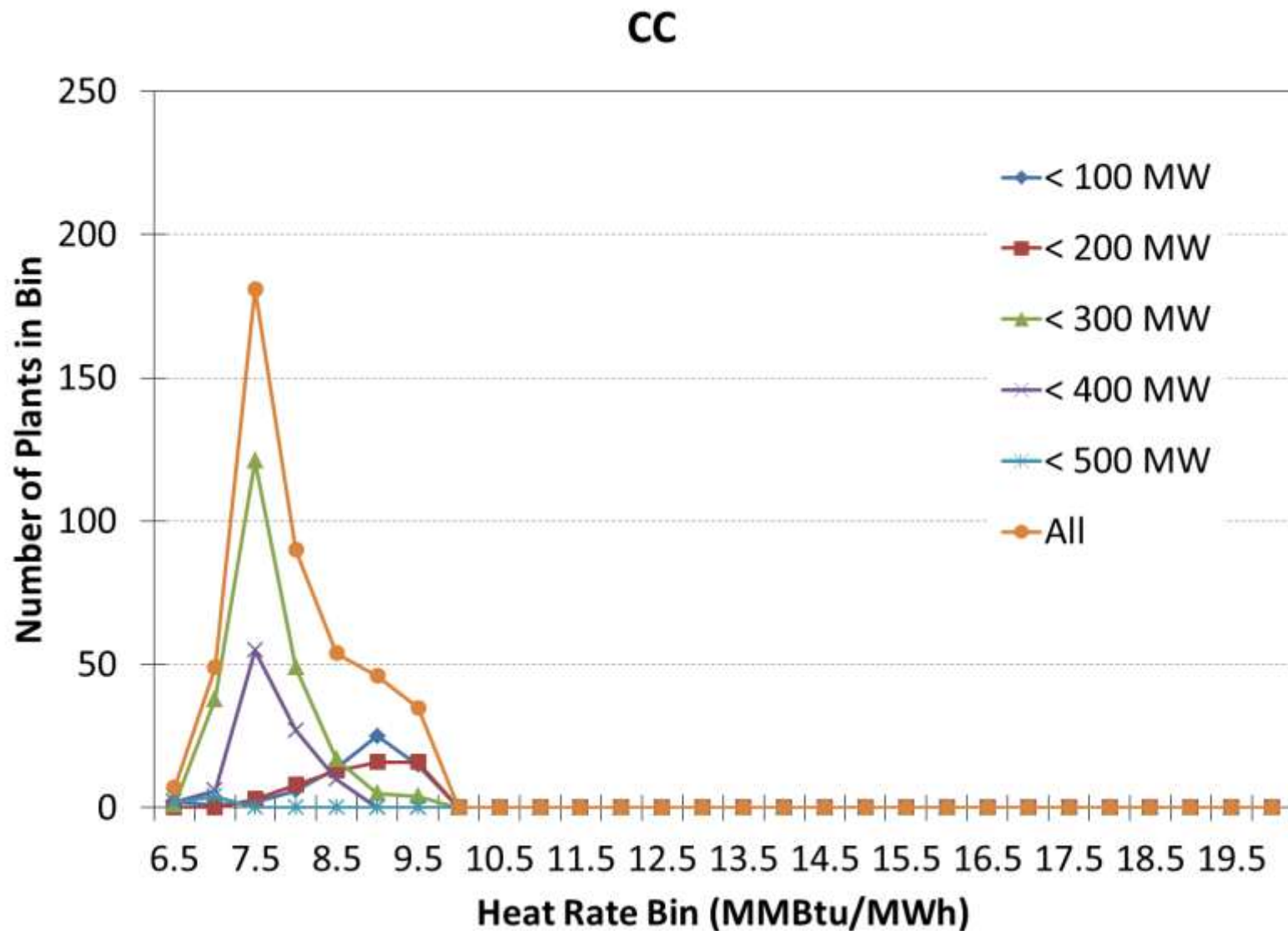
Heat Rate Distributions



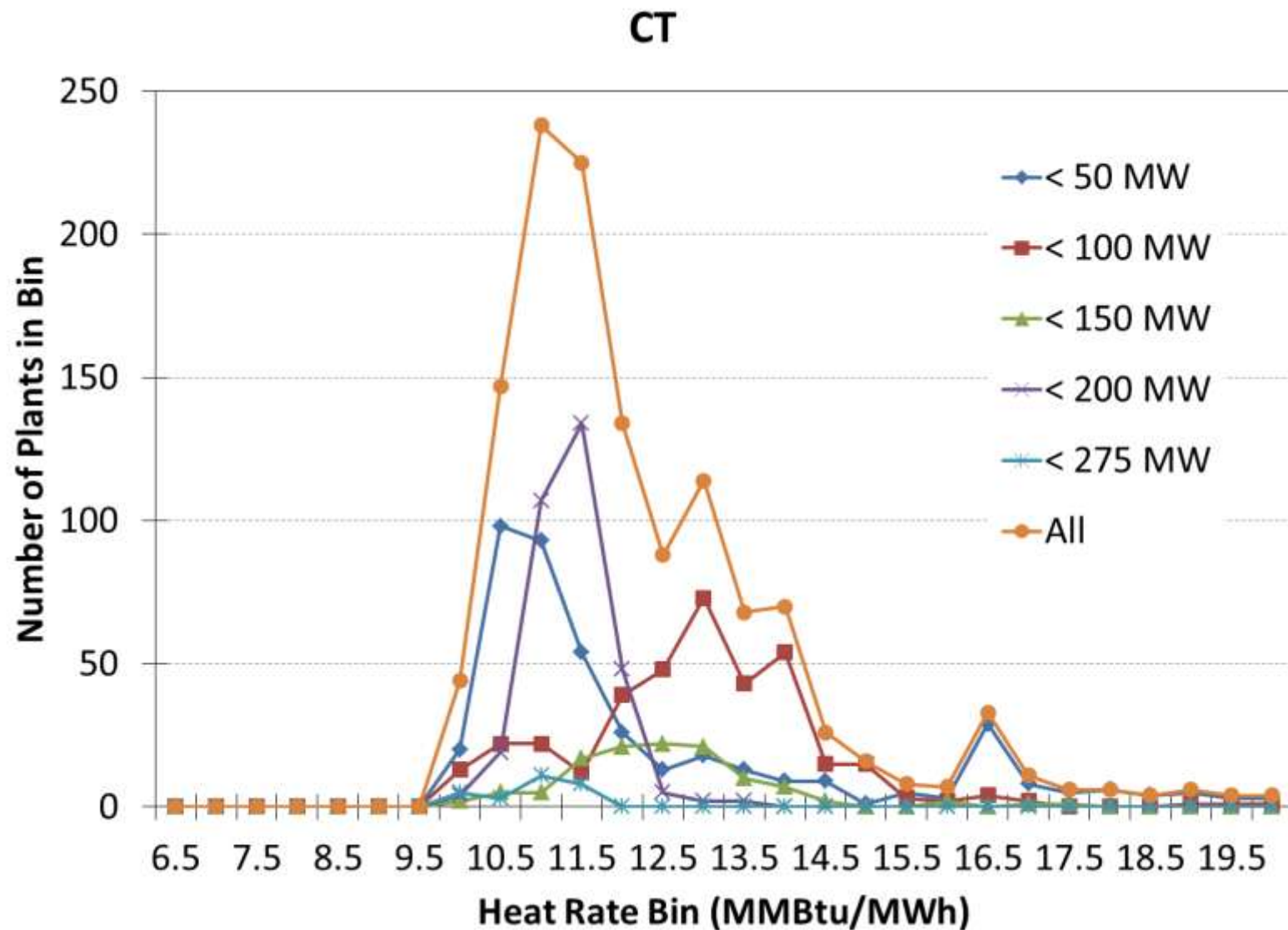
Heat Rate Distributions



Heat Rate Distributions



Heat Rate Distributions



Other Determinations

- **Unit aggregation:**
 - All hydro units in the same plant were aggregated
 - Thermal units of the same type and at the same plant were aggregated up to 120 MW
- **Hydro modeling:**
 - Reservoirs are economically dispatched
 - Subject to monthly energy limits (water availability)

**What will the 2020 thermal
fleet look like?**

**Turns out, that is an
impossible question to
answer!**

Generation Working Group: April 25

- **Cannot determine what the future system WILL look like**
- **But we can make a guess at the drivers of retirements**
 - Natural gas prices
 - EPA regulations
 - Plant age

Trends in Generation Expansion

- **Gas combined cycle and combustion turbines**
 - Low gas prices
 - Market signals for flexibility

Generation Working Group: April 25

Quantity of Retirements

- Identified a range of estimates for the Eastern Interconnection
- Compared forecasts
 - 2013 EIA AEO
 - Brattle Group
 - NREL
 - MISO
 - EIPC

Plant Selection

- Retire plants based on capacity factor from Plexos iterations
- Analyze upgrade costs based on EPA rules
- Identify a database of unit retirements

Ventyx Planned Retirements by 2020

- **Ventyx Retirement Methodology**
 - Unit Specific
 - EIA 860 & 411 and Ventyx research
 - Lifespan Assumptions
 - GADS category
 - Coal units > 100MW = 75 years
 - Coal < 100MW = 65 years
 - Nuclear = 60 years
 - Gas and Other = 55 years.
 - Does not include impact of EPA regulations

Ventyx Planned Retirements by 2020

	ISONE	NYISO	PJM	MISO	SPP	SERC w/o VACAR	VACAR	FRCC	El-Total
Nuclear	628	0	623	566	0	0	0	877	2,694
Oil/Gas Steam Turbine	1,454	4,165	1,941	834	5,626	3,002	0	1,497	18,519
Coal	203	186	7,956	8,757	2,386	6,485	1,821	1,093	28,886
Gas-CC	0	0	0	0	227	0	0	0	227
Gas-CT	0	406	2,143	284	575	101	0	643	4,151
								Total	54,478

**We agreed plant
retirements would be
similar across
scenarios...**

**...but, we didn't reach
the same conclusion
with
thermal plant additions**

Generation Working Group: April 25

- **Questions**

- Would the mix of combined cycles and combustion turbines be the same across scenarios?
- Should the thermal expansion be constant across scenarios?
- How does expansion vary across the regions?

Approach

- **We needed a method that:**
 - Allowed for the input of announced plant retirements
 - Could optimize thermal expansion
 - And allowed us to evaluate multiple thermal expansions

**Where did these goals
lead us?**

Back to ReEDS

- **What is ReEDS?**
 - Long-term capacity-expansion model created by NREL
 - Based on highly discretized regional structure, explicit statistical treatment of the variability in wind and solar output over time, and consideration of ancillary service requirements and costs

- **Why did we choose it?**
 - Reputation
 - http://www.nrel.gov/analysis/reeds/related_pubs.html
 - Configurable
 - Can run multiple scenarios
 - Used for Wind and Solar Expansions

Thermal Fleet Sensitivity

- **Overbuild?**

- Most integration studies keep the thermal fleet constant across all scenarios
- This means there is excess capacity in high renewables scenarios
- We are interested in analyzing at least one additional thermal expansion that is optimized for the regional scenario

- **Why?**

- We expect the thermal fleet expansion to be influenced by policy decisions on renewables

ReEDs Runs

- **Four runs based on the four ERGIS scenarios:**
 - A. No new renewables
 - B. State RPS requirements
 - C. Regional 30% wind and solar
 - D. National 30% wind and solar

ReEDs Results – E.I. Capacity by Scenario

	Conventional Capacity (GW)				
Scenario	Nuclear	Coal	CC	CT/Boiler	Total
No New Renewables	88	231	147	194	660
State RPS	88	230	144	197	660
Regional 30%	88	212	133	173	606
National 30%	88	216	137	178	619

Generator Working Group: Discussion

Canadian Working Group



Canadian Working Group: April 17

- **There are significant transactions between the northern states and Canada**
- **Accurately capturing these relationships is critical to a successful study.**

Approach – IESO

- **Full representation of IESO**
- **Worked closely with Ontario TRC members to:**
 - Identify 2020 Ontario thermal fleet
 - Identify 2020 Ontario renewables
 - Understand changing nature of interchange between regions
- **Sources of data:**
 - Simulated wind data:
<http://www.powerauthority.on.ca/integrated-power-system-plan/simulated-wind-generation-data>
 - Ontario Long Term Plan:
<http://www.powerauthority.on.ca/power-planning/reports/long-term-energy-plan>

Approach

- Full representation of Manitoba Hydro system within MISO region
- Converted average annual generation to:
 - Monthly energy limits for reservoirs
 - Fixed dispatch limits for run-of-river
- Approach and limits approved by TRC members from Manitoba Hydro

Manitoba Hydro Units	
Plant	GWh
Grand Rapids	1,500
Great Falls	750
Jenpeg	910
Kelsey	1,800
Limestone	7,600
Long Spruce	5,800
McArthur	380
Pine Falls	620
Seven Sisters	990
Slave Falls	490
Wuskwatim	1,341
Kettle	8,700
Pointe du Bois	600

Approach

- **Hydro-Quebec and Maritimes**

- Proxy generator
- Development still in progress
 - ISO-NE
 - Synthetic Daily Diurnal Profiles
 - http://www.iso-ne.com/markets/hstdata/dtld_net_intrchnng/ext_intfrc/index.html
 - Other data points
 - NYISO?
 - HQ?
 - IESO?

Canadian Working Group: Discussion

15 Minute Break

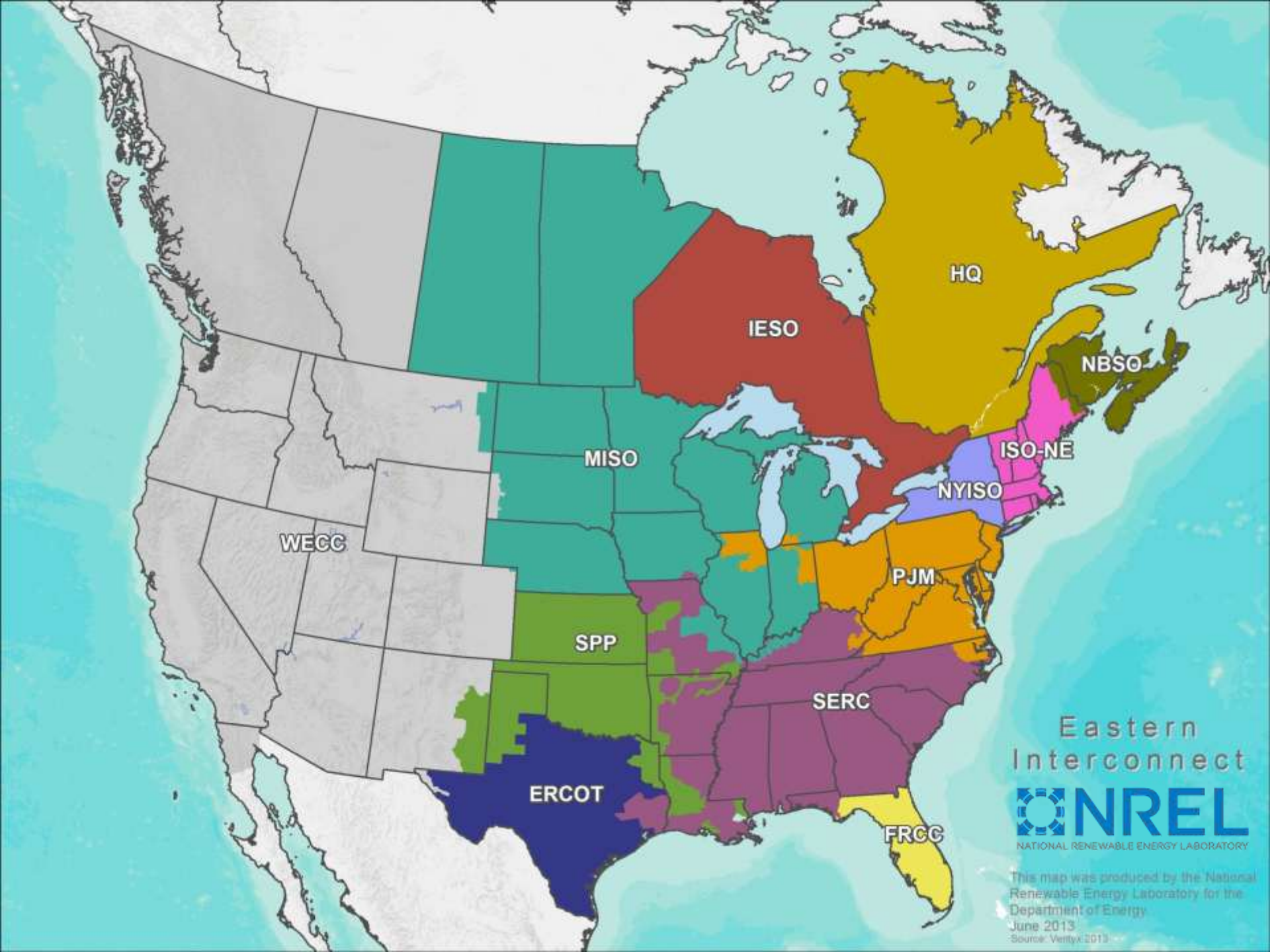


Eastern Interconnect Model Update



Eastern Interconnect Model

- **PLEXOS**
- **Starting point is EI database created by Energy Exemplar**
 - MMWG load-flow case
 - Generator data from Energy Visuals
- **Modifications to generator properties as previously described**
- **Small units at same plant aggregated up to 120 MW**



Eastern
Interconnect
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

This map was produced by the National
Renewable Energy Laboratory for the
Department of Energy
June 2013
Source: Verityx 2013

Transmission

- **Transmission data came from MMWG load flow case**
- **62k nodes, 57k lines, voltages from distribution up to 765 kV**
- **Aggregation**
 - Currently: intra-regional transmission aggregated and inter-regional transmission retained
 - Goal: increase transmission resolution to multiple zones per region

Generation and Load for 2010

- **Generation**

- 6784 generation units
- 880 GW total non-wind capacity
- 28 GW total wind capacity

- **Load**

- 2,888 TWh in 2010
- 520 GW coincident peak demand

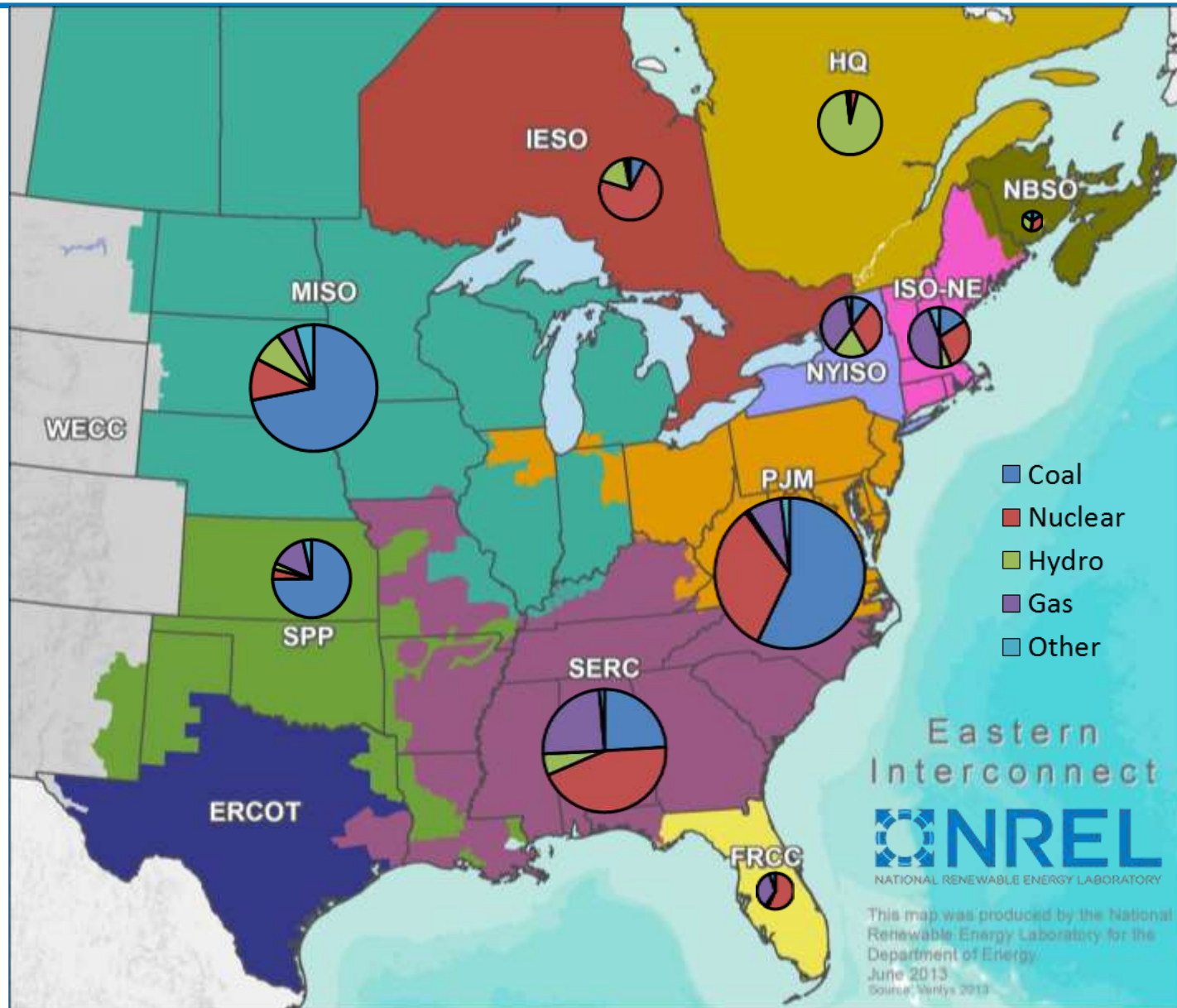
Ongoing Model Improvement

- **Exploring runtime reductions possible:**
 - Transmission representation
 - Generator aggregation and commitment
 - Number of reserves products
- **Implementing changes to:**
 - Generator properties
 - Transmission data and limits
 - Hydro limits

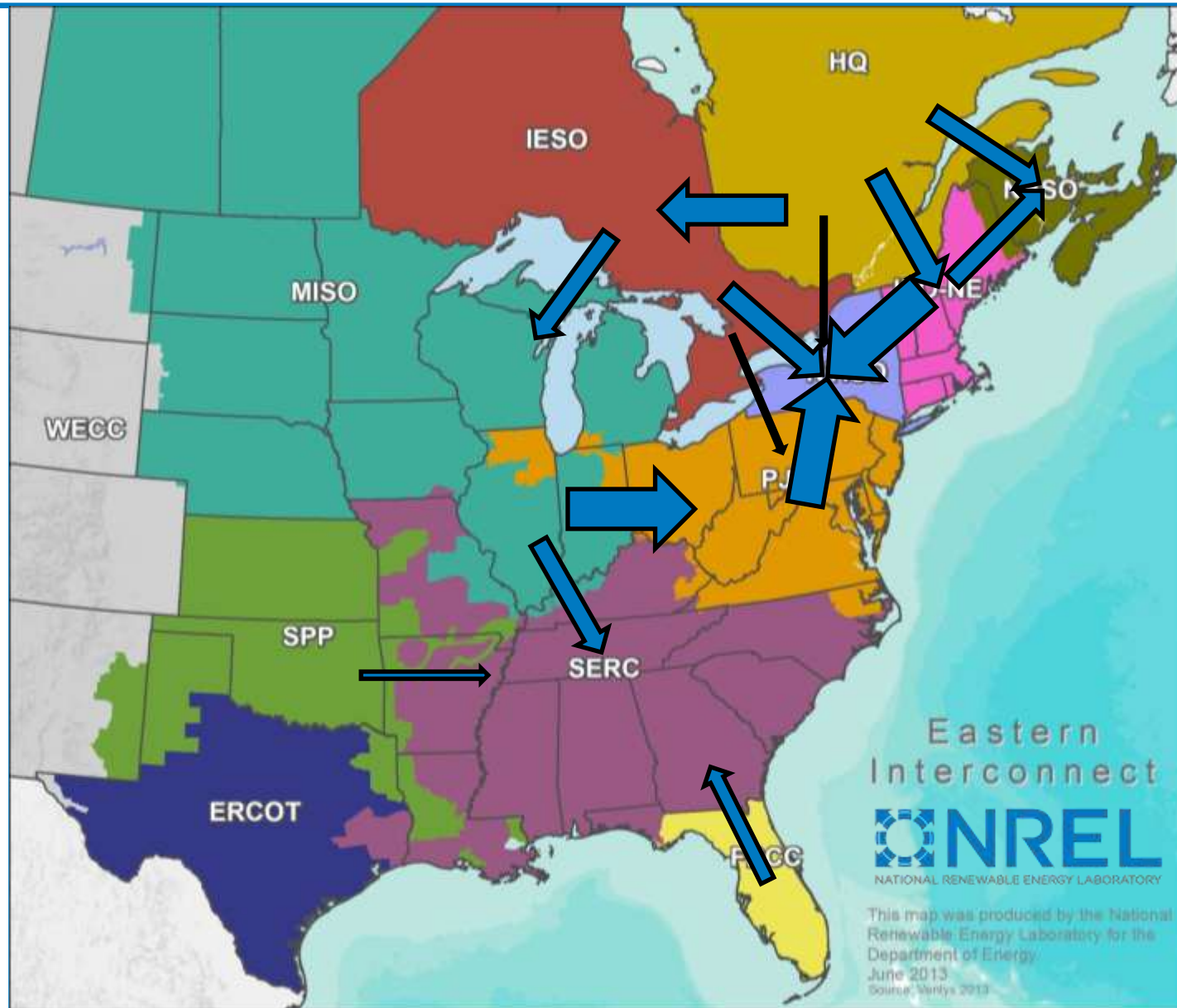
Example 2010 Run Details

- **Day-ahead only**
- **10 EI regions plus import nodes for ERCOT and WECC**
- **Simplified reserves requirement for each EI region**
 - 2.5% of load
 - 10 minute response time
- **Runtime was 12 days**

2010 Run Results: Generation by Region



2010 Run Results: Net Interchange Flows



Model Update: Discussion

Lunch: 30 Minutes



Transmission Working Group



Please Help Us!

- **Need to identify appropriate transmission for future years**
- **The Transmission Working Group is your opportunity to communicate your opinions to us and the other stakeholders**
- **Typically a 1-2 hour web-conference once a month**

Transmission Vocabulary

- **Theoretical Nodal**
 - Every bus, every voltage level
 - Enforce every constraint
- **Feasible Nodal**
 - Voltages above a certain threshold
 - Enforce constraints known to be binding
- **Zonal**
 - Multiple zones within an RTO-sized region
 - Aggregate transmission within each zone
 - Enforce constraints on lines above threshold voltage connecting zones
- **Regional**
 - Aggregate transmission within each region
 - Enforce constraints on lines above threshold voltage connecting regions

Proposal: Use EIPC Transmission Builds

- **EIPC had broad stakeholder participation**
- **EIPC scenarios (mostly) match ERGIS scenarios**

ERGIS Base Case: Use EIPC Scenario 3

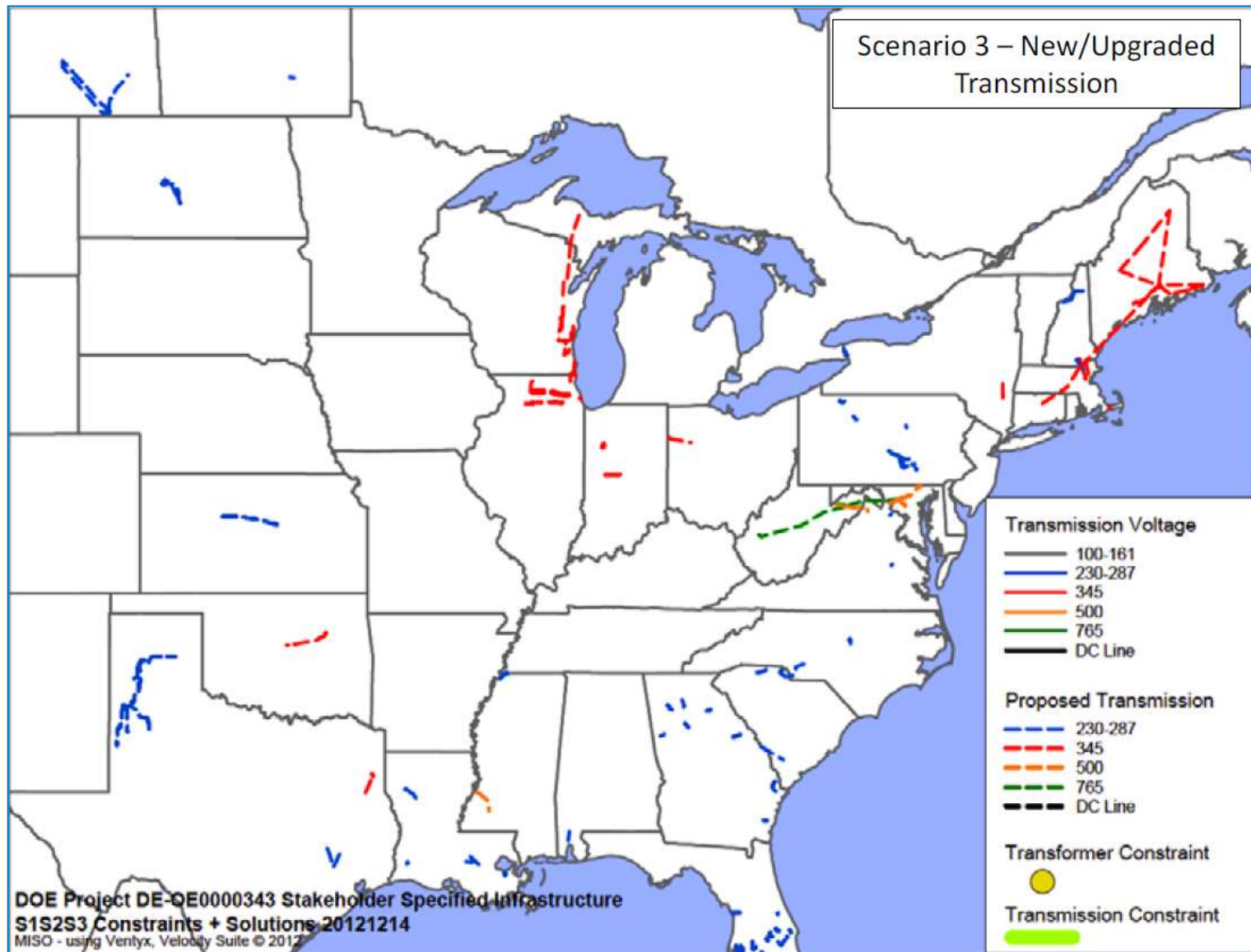


Image is from the EIPC Phase II Final Report: http://www.eipconline.com/uploads/20130103_Phase2Report_Part1_Final.pdf

ERGIS State RPS Case: Use EIPC Scenario 2

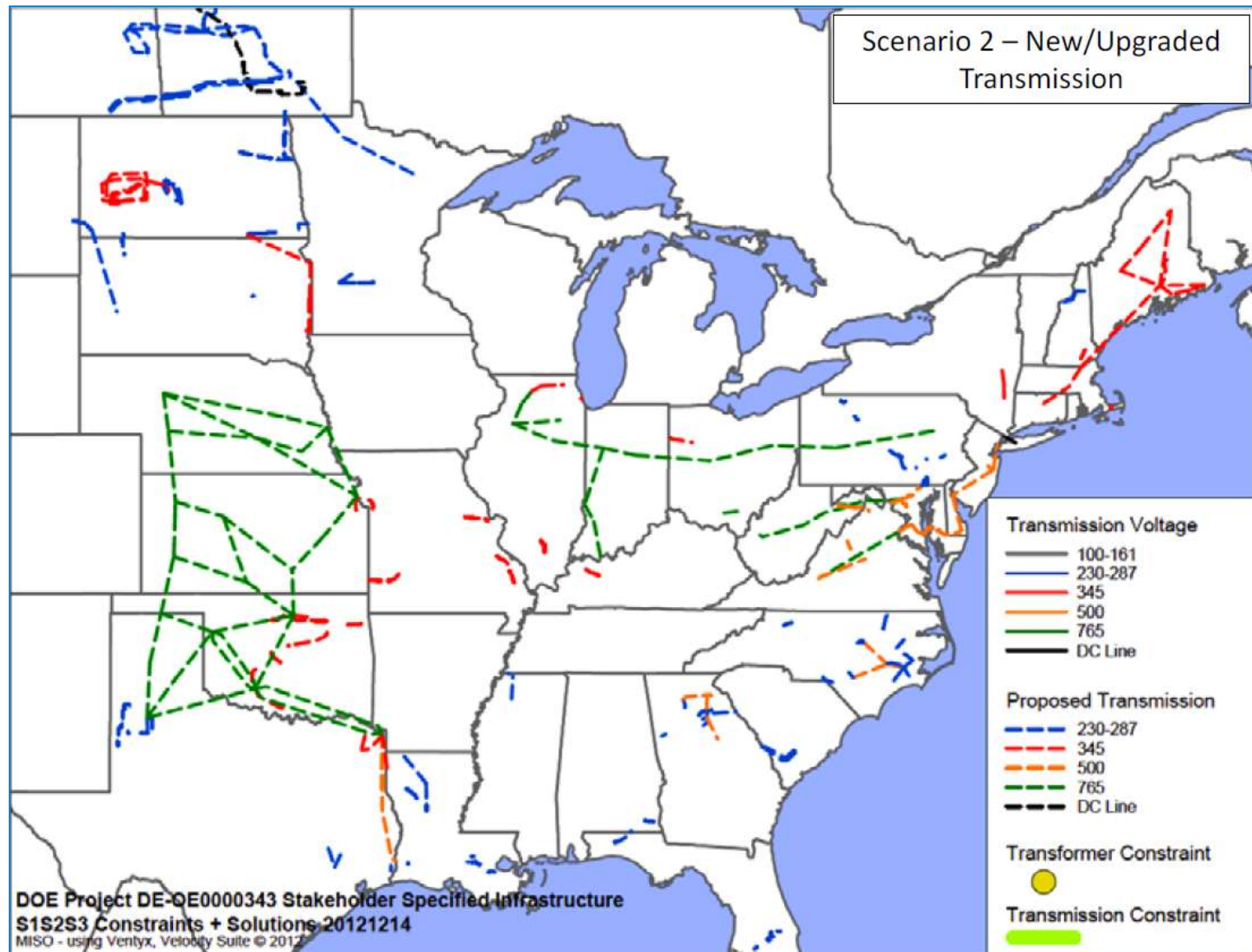


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ERGIS Regional Case: Use EIPC Scenario 2

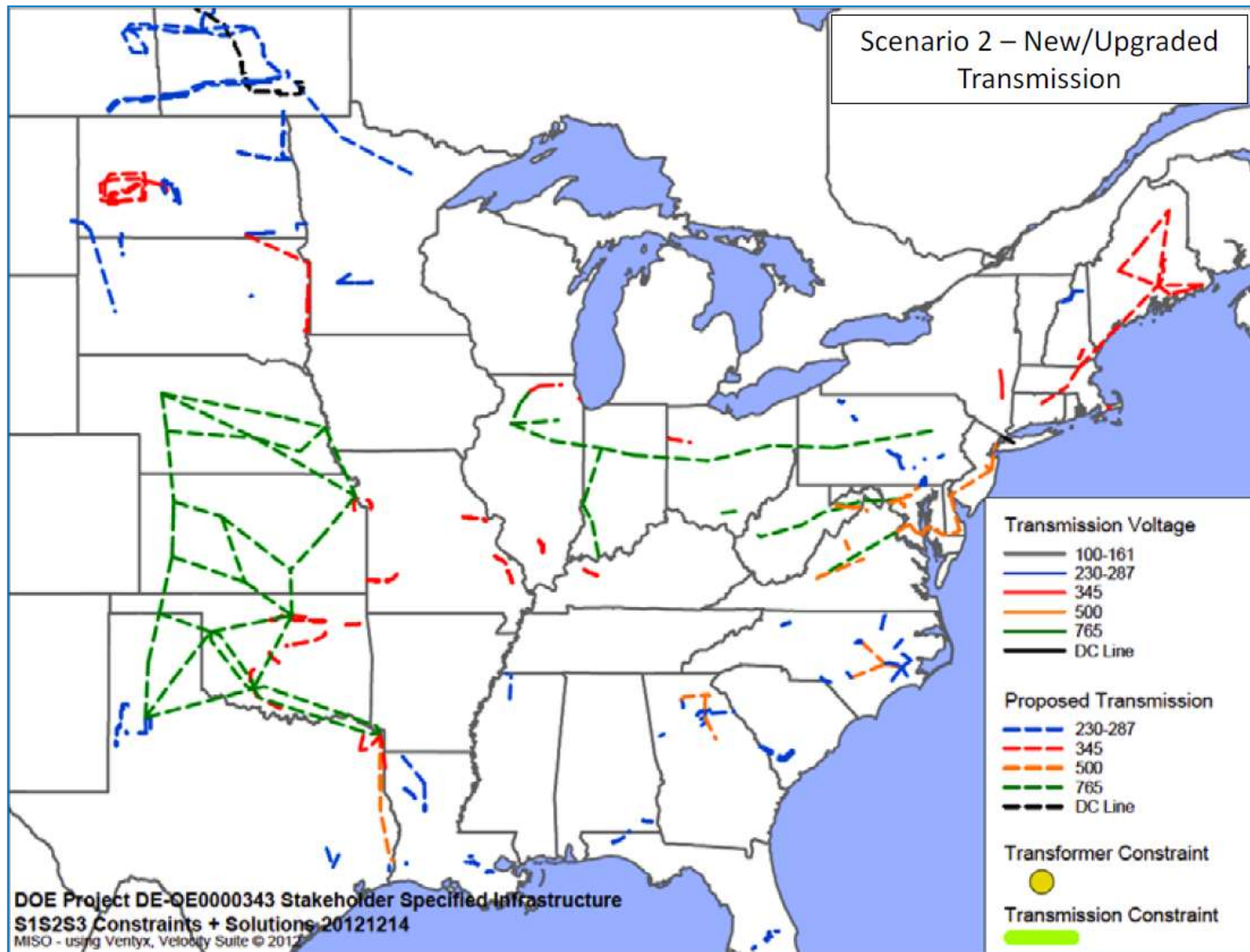


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ERGIS National Case: Use EIPC Scenario 1

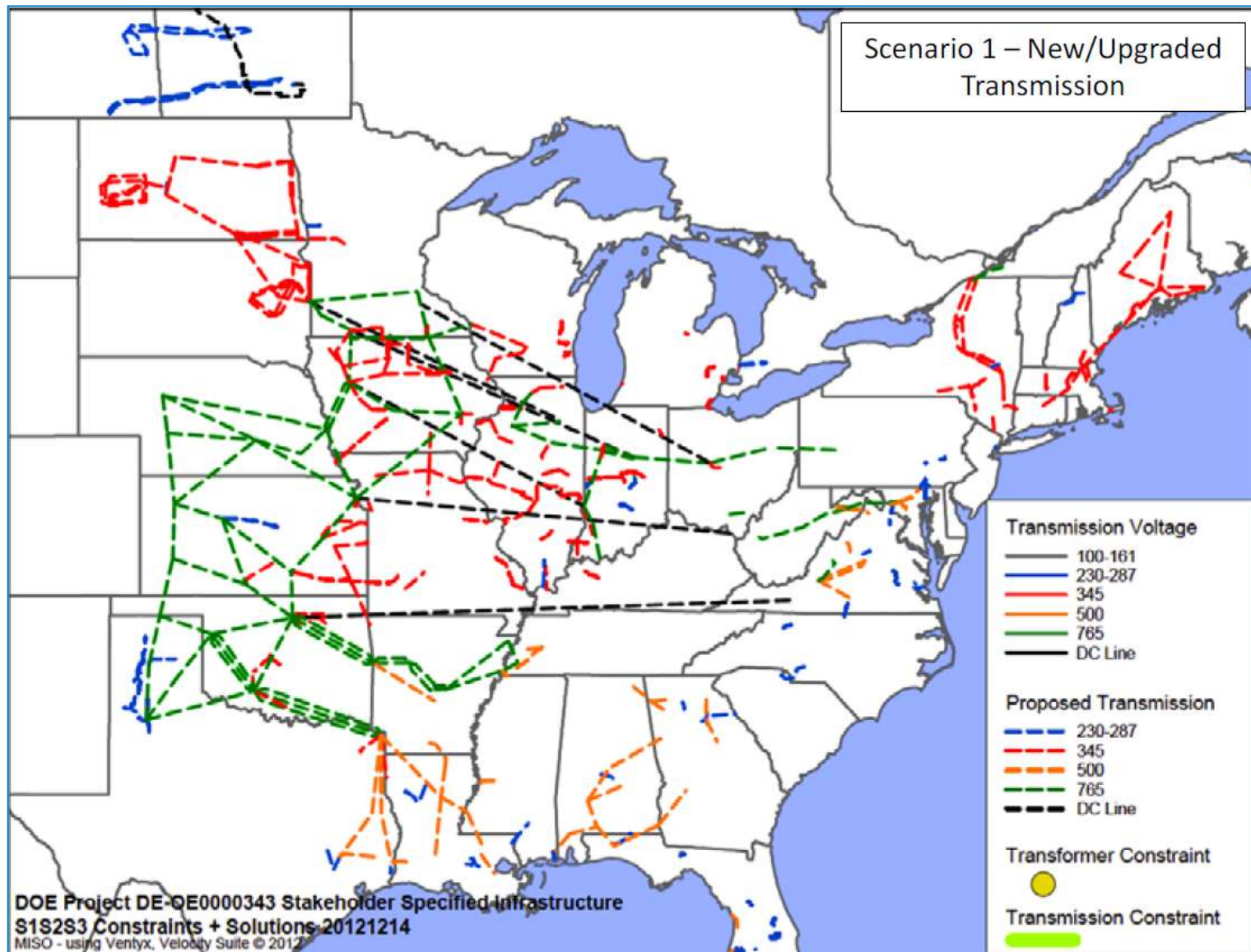


Image is from the EIPC Phase II Final Report: http://www.eipconline.com/uploads/20130103_Phase2Report_Part1_Final.pdf

Possible Zonal Definitions

- **EIPC NEEM regions**
- **RTO zones**
- **Other suggestions?**

EIPC NEEM Regions

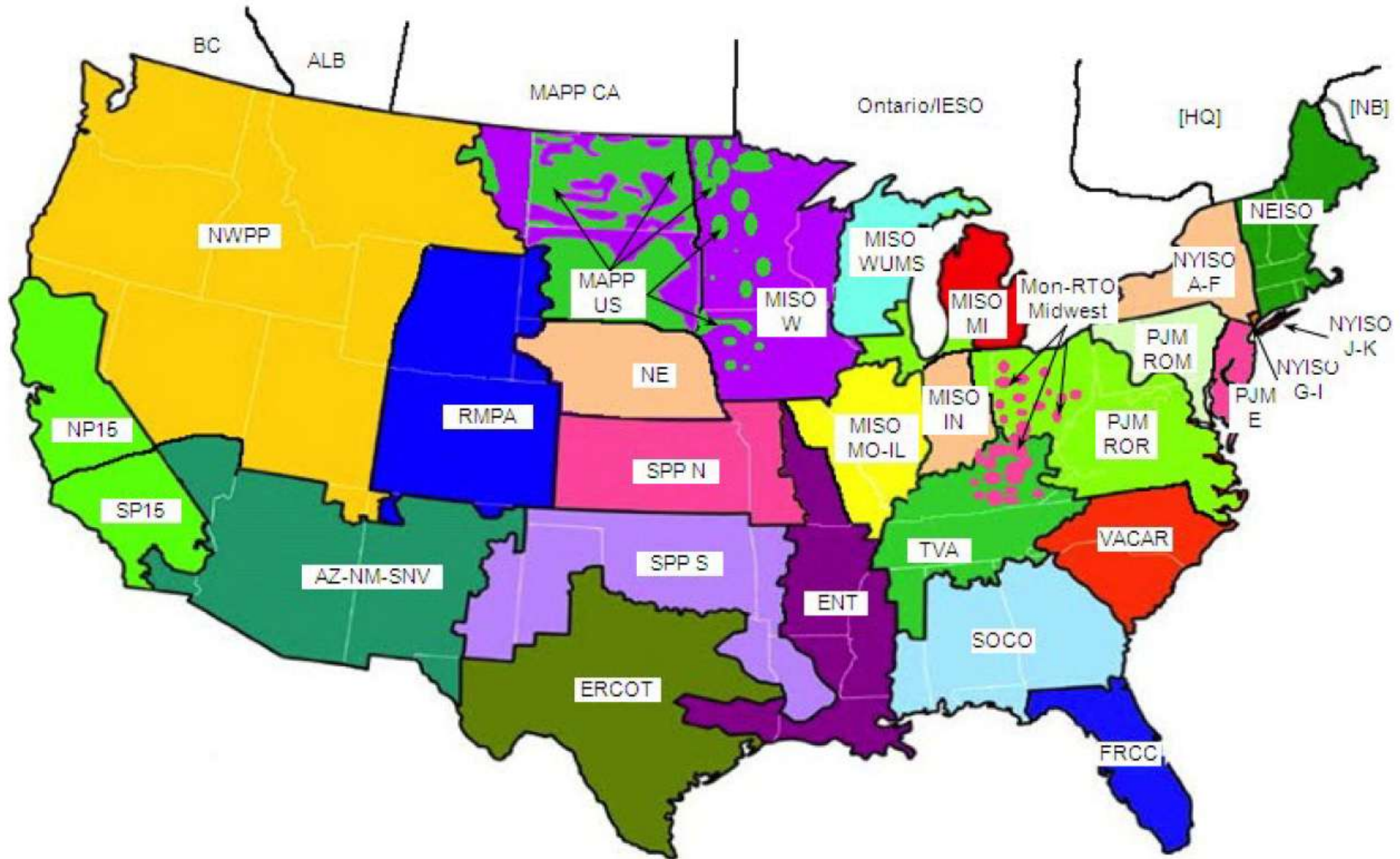
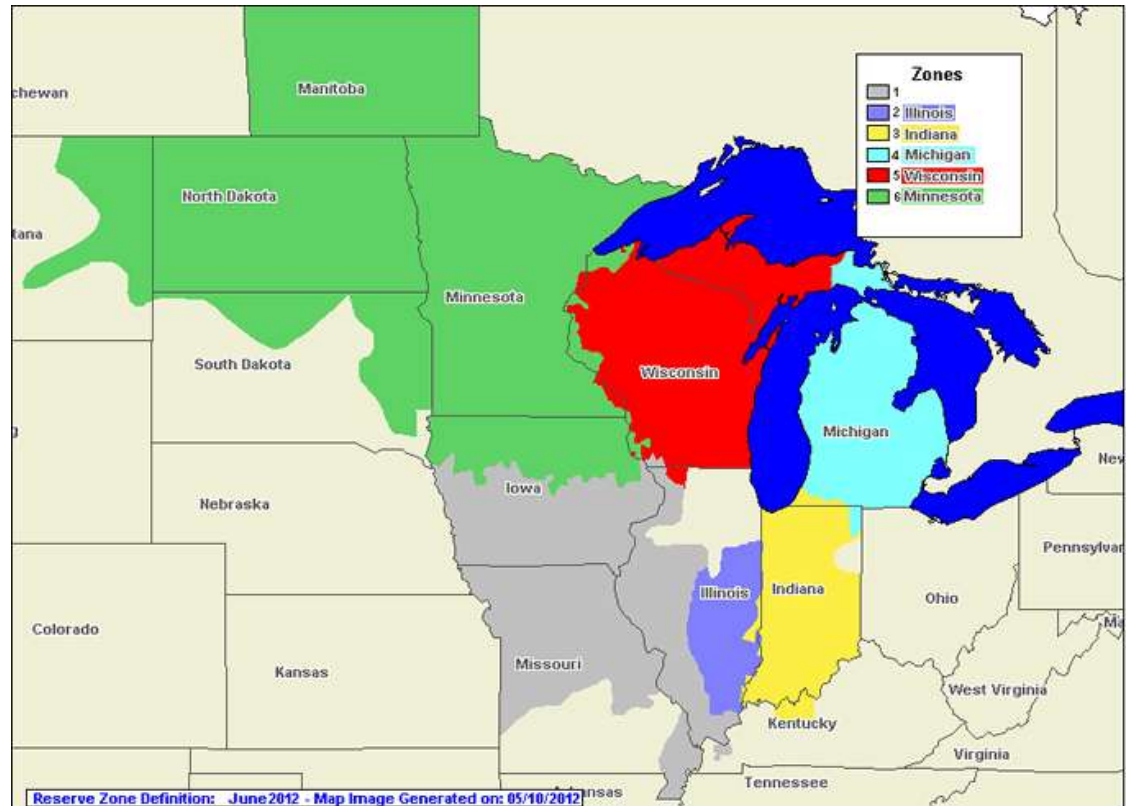


Image is from the EIPC Phase I Final Report: http://www.eipconline.com/uploads/Phase_1_Report_Final_12-23-2011.pdf

RTO Zones

- **RTO zones in RTO areas**
- **Individual BAs in non-RTO areas?**



Transmission Monitoring

- **Above 200 kV only**
 - Of the 57k lines in the EI database, 7.5k are above 200 kV
- **Which lines to monitor?**
 - All lines? (effect on runtime?)
 - Selected lines only?
 - EIPC monitored ~800–1200 lines depending on scenario, based on stakeholders' experience

Transmission Working Group: Discussion

15 Minute Break



Mitigation Options Working Group



Mitigation Options Working Group

- **Goal:**
 - Identify and test operational tools that can address variability and uncertainty in the system
- **Sources of Variability and Uncertainty:**
 - Wind and solar
 - Load
 - Thermal fleet
 - Seams

We Need Your Help

- **Again, the Working Groups are your opportunity to communicate your opinions to us and the other stakeholders**
- **Typically a 1-2 hour web-conference once a month**

Potential Mitigation Options

- **Flexibility Reserve**
- **Reserve Sharing**
- **Interchange Frequency**
- **Unit Commitment**
- **Others?**

Flexibility Reserve

- **Plexos Implementation**
 - Used in WWSIS 2
 - Flexibility Reserves procured in Day Ahead and 4-Hour-Ahead commitment periods
 - Capacity is released for energy in RT
- **Potential for revisions to methodology**

Flexibility Reserve

- **Questions we might answer:**
 - **How does the inclusion of a flexibility reserve impact production costs across the scenarios?**
 - **How does the quantity of flexibility reserve impact product costs across scenarios?**

Reserve Sharing

- **Reserve sharing varies by region**
- **How could reserve sharing be enhanced?**
 - SERC + FRCC?
 - ISO-NE + NYISO?
 - PJM and VACAR?
- **Interesting sensitivity?**

Interchange Frequency

- **Questions we might answer:**
 - Does faster interchange reduce the impact variability and uncertainty?
 - What are the production cost benefits of moving from:
 - Hourly to 15-minute
 - 15-minute to 5-minute

Unit Commitment

- **Questions we might answer:**
 - How much flexibility does a 4-hour ahead unit commitment provide to the system?
 - Does 4-hour ahead unit commitment reduce the need for a flexibility reserve?

What are the most
important sensitivities
to run?

And how do we
prioritize the
sensitivities?

Mitigation Options: Discussion

Proposed

- Flexibility Reserve
- Reserve Sharing
- Interchange Frequency
- Unit Commitment

Your Ideas

- Other sensitivities?
- How to chose?

3-Month Plan



3-Month Plan

- **Working Group Meetings**
 - Transmission
 - Starting in July
 - Topics
 - Expansion
 - Modeling resolution
 - Mitigation Options
 - Starting in July
 - Topics
 - Definition of options
 - Prioritization
 - Design for PLEXOS

3-Month Plan

- **Model runs**
 - Zonal 2010
 - Zonal 2020 No Renewables Scenario
 - Zonal 2020 State RPS Scenario
 - Zonal 2020 National Scenario
 - Zonal 2020 Regional Scenario
- **Critical steps**
 - Wind and solar profiles
 - Transmission expansion

3-Month Plan

- **Fall TRC Meeting**
 - September?
 - Suggestions for location and date?
 - Solar Power International?
 - October 21-24
 - Chicago

Contact Us

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